# Social and Behavioral Determinants of Self-Reported STD Among Adolescents

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***CONTEXT:*** *Adolescents have among the highest sexually transmitted disease (STD) rates. Rich data are now available to characterize the social and behavioral factors that affect adolescent STD risk.*

***METHODS:*** *Data from Wave 1 (1995) of the National Longitudinal Study of Adolescent Health (Add Health) are used to estimate school, neighborhood, family and individual level effects on acquiring an STD. Data from Waves 1 and 2 (1996) of Add Health are also used to estimate the effects of prior STD acquisition and other factors on STD occurrence between waves. Random intercept logistic regression and random intercept piecewise exponential hazard regression are used to account for possible clustering in the Add Health data.*

***RESULTS:*** *Seven percent of sexually experienced teenagers reported ever having had an STD as of Wave 1, and almost 7% reported having had an STD between Waves 1 and 2. Respondents' age, gender, race or ethnicity, and their family background, neighborhood and school characteristics affect STD acquisition at Wave 1. Among teenagers who were sexually experienced at Wave 1, younger age at first intercourse elevates STD risk. Other factors contribute, but to a lesser degree. For acquisition of an STD between Waves 1 and 2, females, blacks, teenagers with lower levels of mother's education and those who have had a prior STD are at higher risk.*

***CONCLUSIONS:*** *Multiple social and behavioral factors influence lifetime history of STD. Age at first intercourse and STD history affect subsequent STD acquisition. Self-reports of STD acquisition in probability samples of the general population are useful.*

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Adolescents have among the highest rates of sexually transmitted diseases (STDs). The Centers for Disease Control and Prevention surveillance data indicate that in 1996, there were more than three million STD cases among U.S. teenagers, and these cases accounted for one-quarter of all reported STD infections.[1] In addition to the known reproductive health sequelae of STDs, their prevalence also suggests substantial economic and psychological costs to young people.[2] Consequently, primary and secondary prevention of STDs, including HIV and AIDS, continues to be a public health priority, especially for adolescents and young adults.[3]

Although adolescents are a high STD risk subpopulation, until recently it has been difficult to characterize the factors that affect STD acquisition among this population beyond a small number of demographic and behavioral variables. Prior to the release of the National Longitudinal Study of Adolescent Health (Add Health), only the National Survey of Adolescent Males, the National Survey of Family Growth (which sampled females of reproductive age) and the Youth Risk Behavior Surveys could be used to provide general population estimates of adolescent reproductive health outcomes. Add Health is unique in this regard because it includes males and females, detailed race and ethnicity measurement, multiple indicators of reproductive health behaviors and outcomes, and information on multiple social contexts. In addition, it has recorded information on multiple episodes of STD acquisition. Wave 1 interviews took place between April and December 1995; Wave 2, between April and August 1996.

This study exploits the richness of the Add Health data to investigate how school, neighborhood, family and individual factors affect the risk of STD acquisition in a national sample of adolescents. We address four interrelated questions. First, what are the determinants of ever having had an STD regardless of sexual experience? Second, what are the determinants of age at first intercourse? Third, among sexually experienced adolescents, what are the effects of age at first intercourse on ever having had an STD? Finally, among sexually experienced adolescents, what are the determinants of acquiring an STD between survey waves, and specifically, to what extent do age at first intercourse and STD history contribute to STD risk? To answer these questions, we focus exclusively on self-reported STD. There appears to be no general population survey of adolescents that uses STD biomarkers (e.g., urine tests).*

*Add Health has thus far collected three waves of data. Wave 3, conducted in 2001 and 2002, administered STD biomarker tests. By then, however, most members of the sample were young adults. Because our interest is in the acquisition of STDs during adolescence, in this article, we focus on the STD self-report information available in Waves 1 and 2. In related work in progress, we use the Wave 3 biomarker test results to investigate the social and behavioral epidemiology of STD acquisition in young adults. In that work, we also examine the connection between self-reports and the results of biomarker tests for several STD pathogens.

## BACKGROUND

Much of the prior research on STD risk assessment has focused on individual-level determinants,[4] although more recent theoretical and methodological developments cast individual risk within larger social and epidemiological contexts.[5] An emerging model of STD risk incorporates biological, behavioral and social factors.[6] Specifically, biological processes influence individuals' susceptibility, with the biological factors partially determined by sexual and protective practices. Sexual and protective practices, in turn, are influenced by environmental factors, including social context and epidemiological conditions. Consistent with that emphasis, this study focuses exclusively on adolescents, and examines three social contexts that are especially salient for them—their families, neighborhoods and schools.

Adolescents are at increased risk of STD because they are more likely to engage in such risk-taking behaviors as unprotected sex, multiple sexual partners and sexual relationships of short duration,[7] and because of increased physiological susceptibility.[8] Age at first intercourse is correlated with many of these risk-taking behaviors and can be used as a marker for risky sexual behavior.[9] Teenagers with early onset of sexual activity tend to have more recent partners and more lifetime partners, and are less likely to use condoms, than those with later onset.[10] Moreover, early age at first intercourse is independently associated with a positive STD history among sexually active females.[11] In this article, we conceptualize age at first intercourse as a key risk-related behavior. Thus, we examine the determinants of age at first intercourse to better understand the effects of school, neighborhood, family and individual factors and STD history.

Adolescents' social and demographic characteristics, such as age, gender, race and ethnicity, and nativity status, are associated with STD risk because of group differences in sexual norms, sexual and protective practices, sexual networks, underlying disease prevalence and biology.[12] Older teenagers, because they are more likely to be sexually active and have accrued more sexual experience, have higher STD risk than younger adolescents.[13] Adolescent females are at higher STD risk than males, in part because of their greater biological susceptibility.[14] Although adolescent females tend to have older ages at first sex and fewer sexual partners than adolescent males,[15] they do not have uniformly lower STD risk because of differences in partners' behaviors and sexual networks.[16] Racial and ethnic variability in STD risk reflects differences in the social and cultural contexts within which sexual activity occurs, and these differences translate into differentials in risk-taking behaviors, such as unprotected sex, age at first intercourse and numbers of sexual partners, as well as reflect socioeconomic differences.[17] Racial and ethnic variability in risk-taking behaviors do not explain all variability in STD risk, however, because sexual networks and underlying disease prevalence within those networks also have independent effects.[18] For adolescents, surveillance data indicate that blacks, Hispanics and Native Americans have higher STD rates than whites; that Asians have lower rates; and that gender, race and ethnicity interact to some extent.[19] Lastly, although few previous studies have investigated the effect of nativity status on STD risk, we hypothesize that foreign-born teenagers are at lower STD risk than U.S.-born teenagers because they are less likely to engage in high-risk behaviors, including early onset of sexual activity.[20]

Families provide role models, shape sexual attitudes, set standards for sexual conduct, control and monitor adolescents' behaviors, and constitute the most proximate social and economic environments for adolescent development.[21] Adolescents living with both biological parents have the optimal opportunity for overall well-being,[22] and are less likely than those in other family situations to engage in sexual risk-taking behaviors such as early sexual initiation.[23] Thus, we expect teenagers living with both biological parents to be at lower STD risk than those living in other family situations. Family socioeconomic status, partially operationalized as parents' education, is also associated with adolescent reproductive health behaviors. Highly educated parents tend to have higher educational aspirations for their children. These higher aspirations should, to some extent, discourage sexual activity and encourage contraceptive use (e.g., condom use) among the sexually active,[24] which should reduce adolescents' likelihood of experiencing an STD. Family processes, especially parental monitoring and supervision of adolescents' activities, are associated with sexual risk-taking behaviors. Specifically, greater parental monitoring is associated with older ages of sexual initiation, smaller numbers of sexual partners and more consistent contraceptive use,[25] all of which suggest lower STD risk. The extent to which families exert a direct effect on adolescent STD risk is, however, unknown.[26] Thus, we investigate direct and indirect effects (through age at first intercourse) of family background on STD risk.

Adolescents' neighborhoods of residence also may affect STD risk by providing local opportunities, institutional resources, normative environments and epidemiological backdrops that shape their sexual life course. Conceptualizations of neighborhoods typically emphasize structural and social dimensions. These include socioeconomic and demographic composition (structure), and formal and informal networks that shape such social processes as collective monitoring, social control and norm-setting (social dimensions). Social processes are thought to mediate the effects of structural characteristics.[27] A growing literature shows that neighborhood conditions influence adolescent sexual risk-taking behavior, including onset of sexual activity.[28] Studies mapping the sexual networks of populations at high risk of STDs show that neighborhood and sexual network boundaries are correlated.[29] Thus, physical deterioration of neighborhoods is associated with lower socioeconomic status, which in turn is associated with a breakdown in social relations, with fewer effective sanctions and social controls to regulate behavior.[30] In such neighborhoods, high-risk behaviors are more prevalent, and STD rates are increased.[31] We investigate whether the Add Health data reveal associations between neighborhood socioeconomic

conditions and self-reported STD, and the extent to which age at first intercourse mediates neighborhood effects.

We also hypothesize that adolescents' school contexts are associated with STD risk. Because adolescents spend so much time at school and because the social relationships established at school are instrumental to adolescent development, schools can have a profound impact on adolescent well-being and development.[32] School structural attributes affect norms and attitudes about dating practices and acceptable sexual behaviors. Studies of the effects of school characteristics on sexual risk-taking behaviors have found that racial composition, whether a school is public or private, and other aspects of school social environment are associated with age at first intercourse and number of sexual partners.[33] Consequently, we incorporate school characteristics into our analyses of both the probability of contracting an STD and age at first intercourse.

Lastly, to better characterize STD experiences during adolescence, we also investigate the determinants of STD occurrence between the Wave 1 and Wave 2 interviews. We hypothesize that individual, family, neighborhood and school factors associated with the report of an STD at Wave 1 will also be associated with the report of an STD occurring between waves. We are especially interested in whether age at first intercourse remains a significant determinant of STD acquisition between waves, and whether a positive STD history at Wave 1 predicts subsequent acquisition.

## METHODS

### Data and Sample

Add Health was designed to assess the general, sexual and reproductive health status of adolescents in the United States.[34] The details of the Add Health study design are described in detail on the project's Web site.[35]

We began with the full Wave 1 sample (N=20,745). To obtain population-based estimates, we dropped respondents not assigned Wave 1 sample weights. Because the observations in the sample are nearly but not completely nested—adolescents within households, within neighborhoods (i.e., census tracts), within school communities—our analytic data set includes only those observations for which we could establish perfect hierarchical nesting. In addition, we randomly selected one teenager in households with multiple respondents. Further exclusions for consistently poor data, missing STD information or incomplete data on parental presence resulted in a final analytic sample of 16,494 adolescents.

For the analysis of age at first intercourse, we exclude respondents who lack a complete date of first intercourse, which reduces the sample to 15,633. Some of our analysis is based on adolescents who were sexually experienced by the Wave 1 interview, which reduces the sample to 6,321. To investigate STD risk between waves, we use the sample of 3,396 sexually experienced teenagers interviewed at both.

### Measures

• *STD outcome variables.* We created two binary STD outcome variables based on self-reports from a series of questions about sexual behavior, contraception and STDs; responses were elicited by audio computer-assisted self-interview (audio-CASI) techniques. The first STD variable is measured as ever having had any STD as of the Wave 1 interview date. Respondents were asked "Have you ever been told by a doctor or nurse that you had" for each of the following STDs: chlamydia, syphilis, gonorrhea, HIV or AIDS, genital herpes, genital warts, trichomoniasis, hepatitis B, bacterial vaginosis (for female respondents) and nongonococcal vaginitis (for female respondents). This battery of questions was limited to the subsample of respondents who responded affirmatively to a question (described below) about whether they had had heterosexual vaginal intercourse (described below).* We code the Wave 1 STD variable as $Y_1$=1 if an adolescent responded affirmatively to any of the listed STDs (except HIV or AIDS) and $Y_1$=0 if not.† The second STD variable is measured as having acquired any STD between the Wave 1 and Wave 2 interviews. This measure is based on the same criteria and questions listed above, except that respondents were asked whether they had acquired a new STD since their last interview. We coded the Wave 2 STD variable as $Y_2$=1 if an adolescent responded affirmatively to any of the listed STDs (except HIV or AIDS) and $Y_2$=0 if not.

• *Age at first intercourse.* We treat age at first intercourse as an outcome in its own right, to examine the extent to which it mediates the other covariate effects on the STD outcome. This variable is constructed from responses to two questions about sexual activity. Using audio-CASI, all respondents were asked, "Have you ever had sexual intercourse? When we say intercourse, we mean when a male inserts his penis into a female's vagina." If the response was affirmative, the next question was, "In what month and year did you have sexual intercourse for the very first time?" We coded age at first intercourse in months since exact age 11, with an indicator for censoring at the Wave 1 interview date. Individuals reporting an age at first intercourse younger than 11 are excluded from the analysis on the ground that such early onset is unlikely to be by the respondent's choice. Age at first intercourse is modeled as a piecewise exponential hazard regression with six-month hazard segments and a random intercept at the school community level. Also, age at first intercourse is used as a covariate in some of the STD regressions. For this purpose we add dummies for ages 11–13, 14–16, and 17 and older, with the youngest age-group as the reference. We include another dummy to retain respondents with known sexual experience but unknown age at first intercourse.

• *Individual characteristics.* The included social and demo-

*This definition of sexual experience is a data-imposed limitation. It hinders our ability to assess STD risk among adolescents who engage in anal intercourse and other types of sexual activity, either exclusively or primarily.

†Cases of HIV and AIDS are excluded from both measures. Because the epidemiological profile for HIV and AIDS differs from that of other STDs (more common among males in this age-group), we eliminated HIV and AIDS from consideration in our analysis. This resulted in a loss of five cases.

graphic attributes of adolescents are age, gender, race and ethnicity, and nativity status. Age is measured in years and is included as a linear term in the STD regressions but not in the age at first sex regression. For race and ethnicity, we give priority to any mention of being Hispanic, with respondents classified as Hispanic, non-Hispanic white, non-Hispanic black, non-Hispanic Asian, non-Hispanic Native American and non-Hispanic other. To test for possible country of origin differences among Hispanics, we further categorize this group as Cuban, Puerto Rican, Mexican American or other Hispanic. (We were also interested in Asian American subgroups, but there are too few STD cases in the data to sustain that level of detail.) Non-Hispanic white is the reference. Additionally, we include a gender by race and ethnicity interaction term found to be statistically significant in our preliminary work—white males. Nativity status is binary—whether an adolescent was born in the United States; the reference category is U.S.-born. In the analysis of STD risk between Waves 1 and 2, we also include a measure of STD status at Wave 1.

• *Family characteristics.* We used the information in the Add Health household roster at Wave 1 to construct a detailed family structure variable categorized as two biological parents, biological mother with stepfather, biological father with stepmother, biological mother with cohabiting partner, biological father with cohabiting partner, biological mother only, biological father only and all other situations. The two biological parents category is the reference. Mother's and father's education are separately coded as years of schooling completed. For a resident parent whose education was not reported, the missing value was imputed using conditional mean imputation.*[36] (Household income was included in our early models, but its coefficient was never statistically significant, and the variable was dropped from our final specification.) Add Health elicited parents' occupations in 16 categories. For our measure of father's occupational status, we coded professional, technical and managerial occupations as high status; all others were coded as low status. If a respondent's father was not working at the time of the interview, no occupation was reported in the data; we coded such cases as none. In the regressions, occupational status consists of three dummies, with high status as the reference. (We also examined mother's occupational status, but it was not statistically significant in any of the regressions.) Parental monitoring, represented here by how often each resident parent is home in the morning, is coded as a five-point Likert scale ranging from never (1) to always (5). Add Health includes a battery of items on parental presence. Variable selection was based on theoretical considerations and exploratory analysis. The same point holds for the included measures of neighborhood and school characteristics.

• *Neighborhood characteristics.* We treat census tract boundaries as plausible demarcations of neighborhoods, and retain two of the 1990 census tract variables appended to the Add Health data set.[37] Residential stability is the proportion of individuals aged five and older who have lived in the same household since 1985; unemployment represents the proportion of all adults who are unemployed. In the regressions, we code tract variables in quintile form (1=lowest 20% of the distribution of the tracts and so on up to 5=highest 20% of the distribution of tracts).†

• *School characteristics.* We include two aspects of school structure in the final model. School status is measured as public, private (non-Catholic) or Catholic, with public as the reference. School type is measured as high school, junior high or combination (i.e., schools with grades 7–12), with junior high as the reference.

### Analytic Strategy

We present results for three subsets of the data: all adolescents, regardless of their sexual experience; adolescents who were sexually experienced by the Wave 1 interview date; and adolescents who were sexually experienced by the Wave 1 interview date, were reinterviewed at Wave 2 and had valid STD information at Wave 2. First, we use regression analysis to examine how, in the full sample, individual, family, neighborhood and school characteristics affect STD acquisition at Wave 1 ($Y_1$). Because age at first intercourse may mediate the effects of individual, family, neighborhood and school characteristics on the STD outcome, we estimate a piecewise- exponential hazard model of time to first sex. We then restrict the sample to adolescents who were sexually experienced as of the Wave 1 interview date and reestimate the STD regression, controlling for age at first intercourse. Lastly, we further restrict the sample to those sexually experienced adolescents who were reinterviewed at Wave 2, to regress between-wave STD acquisition ($Y_2$) on individual, family, neighborhood and school factors. All regressions include a random intercept to account for potential clustering effects at the school community level.‡ Allowing for clustering at the tract level does not change the results. Regressions were computed without weights, using Stata 8.2.[38] In exploratory analyses, we included the design variables that were used in the construction of the weights to better understand their relevance. The coefficients of the design variables turned out not to be statistically significant. For this reason, we have excluded these variables from the final models.

## RESULTS

Overall, the mean age at Wave 1 is 15.4 years (Table 1); 51% of respondents are male, 67% are white, 16% are black, 12% are Hispanic (and the largest subgroup is Mexican Ameri-

*Nonresident parents were coded zero on education and parental presence. Any constant would be valid; zero is convenient. Interpretation of contrasts between family types without a defined parent and family types with both parents requires postestimation calculation.

†We computed quintile scores using a tract-level data set. For exploratory purposes, we also treated each tract variable as a dummy variable classification, with categories defined by quintiles.

‡Observations are said to be clustered when individuals within groups are more similar than individuals sampled without respect to group membership. Ignoring clustering can lead to inefficient estimation, as well as biased estimation in nonlinear regression. The intraclass correlation, commonly used in linear hierarchical models, is an indicator of the extent of unexplained clustering. Likewise, the between-group variance component refers to the existence of unexplained clustering.

***TABLE 1. Selected characteristics of respondents, National Longitudinal Study of Adolescent Health, by wave and sample***

| Characteristic | Wave 1 | | Wave 2 |
|---|---|---|---|
| | All (N= 16,494) | Sexually experienced (N=6,321) | Sexually experienced (N=3,396) |
| INDIVIDUAL | | | |
| **Age at Wave 1 (mean)** | 15.4 | 16.4 | 16.0 |
| **Gender (%)** | | | |
| Male | 51.0 | 50.7 | 49.3 |
| Female | 49.0 | 49.3 | 50.7 |
| **Race/ethnicity (%)** | | | |
| White | 66.8 | 63.1 | 63.2 |
| Black | 15.7 | 21.6 | 21.2 |
| Cuban | 0.7 | 0.5 | 0.4 |
| Puerto Rican | 1.3 | 1.7 | 2.0 |
| Mexican American | 6.8 | 6.3 | 6.5 |
| Other Hispanic | 3.4 | 3.2 | 3.4 |
| Asian American | 3.3 | 1.9 | 1.7 |
| Native American | 0.8 | 0.8 | 0.9 |
| Other | 1.1 | 1.0 | 0.8 |
| **Nativity status (%)** | | | |
| U.S.-born | 94.7 | 96.3 | 96.9 |
| Foreign-born | 5.3 | 3.7 | 3.1 |
| FAMILY | | | |
| **Family structure (%)** | | | |
| Both biological parents | 54.1 | 42.5 | 41.5 |
| Biological mother, stepfather | 8.5 | 9.7 | 10.3 |
| Biological father, stepmother | 1.9 | 2.2 | 1.8 |
| Biological mother, cohabiting partner | 4.8 | 6.4 | 6.9 |
| Biological father, cohabiting partner | 0.8 | 0.8 | 0.7 |
| Biological mother only | 20.6 | 23.9 | 26.3 |
| Biological father only | 3.0 | 3.6 | 3.6 |
| Other | 6.3 | 10.9 | 8.9 |
| **Parental education† (mean)** | | | |
| Mother | 13.1 | 12.8 | 12.7 |
| Father | 13.4 | 12.9 | 12.8 |
| **Father's occupational status† (%)** | | | |
| High | 31.3 | 26.6 | 23.5 |
| Low | 64.8 | 68.5 | 71.0 |
| None | 3.9 | 4.9 | 5.5 |
| **Mother's presence in the morning† (%)** | | | |
| Never | 9.1 | 11.7 | 10.7 |
| Almost never | 5.4 | 6.4 | 6.0 |
| Some of the time | 8.0 | 8.2 | 7.9 |
| Most of the time | 13.0 | 12.0 | 12.3 |
| Always | 64.4 | 61.6 | 63.1 |
| **Father's presence in the morning† (%)** | | | |
| Never | 24.8 | 29.0 | 29.9 |
| Almost never | 10.7 | 10.3 | 10.7 |
| Some of the time | 15.2 | 15.0 | 15.4 |
| Most of the time | 13.7 | 11.6 | 10.9 |
| Always | 35.5 | 34.1 | 33.1 |
| NEIGHBORHOOD | | | |
| **Residential stability (mean)** | 55.1 | 55.3 | 55.8 |
| **Unemployed (mean)** | 7.5 | 8.1 | 8.3 |
| SCHOOL | | | |
| **Status (%)** | | | |
| Public | 93.6 | 95.1 | 96.3 |
| Catholic | 3.2 | 2.8 | 2.3 |
| Private | 3.2 | 2.1 | 1.4 |
| **Type (%)** | | | |
| Junior high | 29.7 | 12.5 | 14.8 |
| High | 49.3 | 68.8 | 68.2 |
| Combination | 21.0 | 18.7 | 17.0 |
| OUTCOME | | | |
| **Age at first intercourse** | | | |
| ≤13 | na | 23.6 | 25.9 |
| 14–16 | na | 54.7 | 59.5 |
| ≥17 | na | 13.8 | 7.9 |
| Missing data | na | 7.9 | 6.8 |
| **Sexually transmitted disease** | | | |
| As of Wave 1 | 2.7 | 7.0 | 6.4 |
| Between waves | na | na | 6.7 |

†N is reduced because not all adolescents lived in a family with a mother or father. *Notes:* na=not applicable. All data are weighted. Percentages may not sum to 100 because of rounding. Wave 1 was conducted between April and December 1995; Wave 2 was conducted between April and August 1996.

can) and the remainder are of other racial or ethnic groups. Close to 95% were born in the United States. Fifty-four percent of adolescents live with both biological parents, and 21% live with their biological mother only; the remainder live in stepfamilies, with a biological parent and their cohabiting partner or in other situations. The average parental education is 13.3 years (not shown), and two-thirds of the respondents have fathers in low status occupations. Two-thirds of mothers are always present in the mornings, whereas about one-third of fathers are home at that time. The average level of neighborhood residential stability is 55%; the average neighborhood unemployment rate is 8%. The vast majority (94%) of adolescents attend public school; close to half attend high school, 30% attend junior high school and 21% attend combination schools. Overall, 3% report an STD at Wave 1. Among the sexually experienced, 55% report being ages 14–16 at first intercourse, 24% say they were younger than 14 and 14% say they were older than 16. Seven percent of sexually experienced adolescents report ever having had an STD; moreover, close to 7% report having had an STD between the waves.

There was attrition between Waves 1 and 2, in part because the study design did not allow for tracing seniors who graduated from high school between waves.* Conse-

*We used logistic regression to model Wave 2 attrition for teenagers who were sexually experienced at Wave 1. As might be expected from the study design, older teenagers were significantly less likely to be reinterviewed. Males were significantly more likely to remain in the panel. Compared with teenagers living with both biological parents, those living with biological mother and stepfather were more likely to be reinterviewed. Compared with teenagers whose father's occupational status is high, those whose father did not have an occupation or whose occupational status was low were more likely to be reinterviewed. Compared with teenagers who attended a junior high school at Wave 1, those who attended a high school or a combination school were more likely to be reinterviewed. Lastly, compared with teenagers with an age at first intercourse under age 14, those reporting an age between 14 and 16 were more likely to be reinterviewed. None of the other covariates are associated with attrition.

quently the mean age of those who were sexually experienced does not increase across waves. Also, several of the race, ethnicity and family structure categories have few respondents. The incidence of self-reported STD is low absolutely for all teenagers at Wave 1 because such a high proportion are not sexually experienced, but it doubles for sexually experienced teenagers at Waves 1 and 2.

### STD Risk Among All Adolescents

The likelihood of adolescents' ever having had an STD by Wave 1 significantly increases with age (Table 2). Males are significantly less likely than females to have experienced an STD; the gender difference is greatest for whites. Blacks are significantly more likely than whites to have experienced an STD; there are no differences between whites and Cubans, Puerto Ricans or other Hispanics. However, Mexican Americans are significantly less likely than whites to have had an STD. (Sparse data preclude elaboration of results for Asians, Native Americans and other ethnicities.) Nativity status is not associated with having had an STD.

The effects of family characteristics are modest. Compared with adolescents living with two biological parents, those living with a biological mother and stepfather are significantly more likely to have a history of STD. Although both coefficients for parental education are in the expected direction, only mother's education is significant. Father's occupational status, mother's presence in the morning and father's presence in the morning are not significant.

Both of the neighborhood effects are significant. As residential stability increases, STD risk at Wave 1 decreases, and as the proportion unemployed increases, STD risk increases. As for the school variables, compared with public schools, adolescents who attend private schools have a significantly lower STD risk; there is no difference between public and Catholic schools. Also, compared with youth in junior high, those in high school have a significantly higher STD risk; there is no difference between youth in junior high and combination schools. Lastly, the intraclass correlation is nearly zero and is not significant, which indicates that there is little homogeneity in STD outcomes within school communities once the covariates are taken into account.*

***TABLE 2. Logistic regression of STD acquisition as of Wave 1, by selected characteristics, with random intercept at school community level***

| Characteristic | Coefficient (N=16,494) |
|---|---|
| INDIVIDUAL | |
| **Age at Wave 1** | 0.41*** |
| **Male** | –1.04*** |
| **White male** | –0.58* |
| **Race/ethnicity (ref=white)** | |
| Black | 0.81*** |
| Cuban | –0.64 |
| Puerto Rican | 0.48 |
| Mexican American | –0.68** |
| Other Hispanic | –0.28 |
| Asian American | –0.92* |
| Native American | –0.13 |
| Other | –0.08 |
| **Nativity status (ref=U.S.-born)** | |
| Foreign-born | –0.36 |
| FAMILY | |
| **Family structure (ref=both biological parents)** | |
| Biological mother and stepfather | 0.67*** |
| Biological father and stepmother | 0.31 |
| Biological mother and cohabiting partner | 0.59 |
| Biological father and cohabiting partner | –0.22 |
| Biological mother only | 0.40 |
| Biological father only | 0.22 |
| Other | –0.16 |
| **Parental education** | |
| Mother | –0.06* |
| Father | –0.03 |
| **Father's occupation status (ref=high)** | |
| Low | 0.38 |
| None | 0.37 |
| **Mother's presence in the morning** | –0.08 |
| **Father's presence in the morning** | –0.02 |
| NEIGHBORHOOD | |
| **Residential stability** | –0.11** |
| **Unemployed** | 0.12** |
| SCHOOL | |
| **Status (ref=public)** | |
| Catholic | –0.06 |
| Private | –1.47* |
| **Type (ref=junior high)** | |
| High | 0.67** |
| Combination | 0.26 |
| *Constant* | *–9.52**** |
| *Wald $\chi^2$ (df=31)* | *543.65**** |
| *Intraclass correlation* | *0.01* |

*p≤.05. **p≤.01. ***p≤.001. *Notes:* ref=reference group. Mother's and father's presence in the morning are ordered categorical variables (see Table 1); neighborhood characteristics are continuous variables.

### Age at First Intercourse

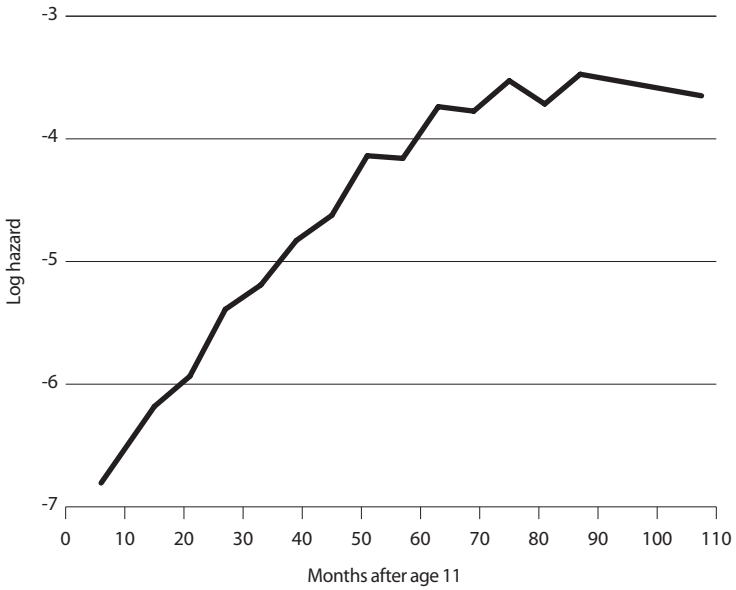
If there are social and demographic risk differentials regardless of sexual initiation status, are there also such differentials among sexually experienced teenagers? For the latter group in a regression of ever having had an STD, it is helpful to control not only for all of the dimensions used thus far, but also for age at first intercourse. All other things being equal, the earlier the initiation of sexual activity, the greater the STD risk. As a measure of risky behavior, age at first sex may mediate the effects of social and demographic characteristics. If so, it should depend on these characteristics. As a check, we present a hazard regression for that outcome. With one exception—the omission of school type—the covariates in this regression are identical to those for Wave 1 STD acquisition listed in Table 2.†[39]

The hazard of first sexual intercourse increases mono-

*In the null model (model without covariates), the intraclass correlation is larger and statistically significant. The observed covariates appear to account for similarity among observations due to clustering.

†There are obvious structural zeros in the age by junior high–combination school–high school classification (e.g., there are no 16-year-olds in junior high school). To ignore these structural zeros, as well as the age selectivity inherent in a classification defined by grade, would be to invite spurious comparisons (source: reference 39).

***FIGURE 1. Baseline hazard of age at first sexual intercourse, Add Health***




tonically up to about age 17, and is essentially flat thereafter (Figure 1). Age at first intercourse depends in part on social and demographic factors at the individual and family levels, on parental presence and on neighborhood and school characteristics (Table 3). At any age, males are more likely than females to be sexually experienced. The gender difference, however, reverses for whites. Compared with white adolescents, blacks are more likely to be sexually experienced, and Mexican Americans, other Hispanics and Asian Americans are less likely to have ever had intercourse. There are no significant differences between whites and Cubans, Puerto Ricans, Native Americans or adolescents of other ethnicities. Compared with teenagers born in the United States, foreign-born teenagers are less likely to be sexually experienced.

Compared with teenagers living with both biological parents, those living in stepfamilies (especially those living with their biological mother and a stepfather) are more likely to be sexually experienced. Father's occupational status is not associated with onset of sexual activity. Increases in maternal and paternal education decrease the risk of sexual activity. Also, increased morning presence of either parent significantly decreases the risk of first sexual intercourse.

Only one of the neighborhood measures is associated with the risk of first sexual intercourse: As the proportion of resident adults who are unemployed increases, so does the risk.

As for school characteristics, compared with teenagers in public schools, those in private schools are at lower risk of sexual activity. There is no difference between public and Catholic schools. Lastly, the between-group variance component is small but significant, suggesting that teenagers in the same school community are somewhat more like one another in age at first sexual intercourse than teenagers from different school communities, even when important individual and familial characteristics are controlled for.

### STD Risk Among Sexually Experienced Adolescents

Having shown that age at first intercourse is associated with determinants of STD acquisition at the individual, family, neighborhood and school levels, we turn next to the analysis of STD acquisition among sexually experienced teenagers (Table 4). In the first regression, the risk of acquiring an STD by Wave 1 is reestimated with age at first sexual intercourse as a covariate. Current age is positively associated with STD risk at Wave 1. Age at first intercourse has a strong effect on STD outcome at Wave 1, even controlling for current age. Compared with teenagers who began sexual activity at age 13 or younger, those who

***TABLE 3. Piecewise exponential hazard regression of time to first intercourse, by selected characteristics, with random intercept at school community level***

| Characteristic | Coefficient (N=15,633) |
|---|---|
| INDIVIDUAL | |
| **Male** | 0.23*** |
| **White male** | –0.44*** |
| **Race/ethnicity (ref=white)** | |
| Black | 0.13** |
| Cuban | –0.19 |
| Puerto Rican | –0.01 |
| Mexican American | –0.25*** |
| Other Hispanic | –0.18* |
| Asian American | –0.63*** |
| Native American | –0.18 |
| Other | –0.17 |
| **Nativity status (ref=U.S.-born)** | |
| Foreign-born | –0.61*** |
| FAMILY | |
| **Family structure (ref=both biological parents)** | |
| Biological mother and stepfather | 0.42*** |
| Biological father and stepmother | 0.18* |
| Biological mother and cohabiting partner | 0.22 |
| Biological father and cohabiting partner | –0.07 |
| Biological mother only | –0.02 |
| Biological father only | –0.09 |
| Other | –0.26 |
| **Parental education** | |
| Mother | –0.02* |
| Father | –0.02* |
| **Father's occupation status (ref=high)** | |
| Low | 0.04 |
| None | 0.04 |
| **Mother's presence in the morning** | –0.06*** |
| **Father's presence in the morning** | –0.04*** |
| NEIGHBORHOOD | |
| **Residential stability** | 0.01 |
| **Unemployed** | 0.05*** |
| SCHOOL | |
| **Status (ref=public)** | |
| Catholic | –0.11 |
| Private | –0.57*** |
| *Constant* | *6.31*** |
| *Likelihood ratio $\chi^2$ (df=42)* | *5,913.21**** |
| *Between-group variance component* | *0.09**** |

*p≤.05. **p≤.01. ***p≤.001. *Notes:* ref=reference group. Mother's and father's presence in the morning are ordered categorical variables (see Table 1); neighborhood characteristics are continuous variables.

began at age 14 or older are significantly less likely to have had an STD. Males continue to be less likely than females to have had an STD. However, the coefficient for the white male interaction is no longer significant, which suggests that the lower risk observed in the STD regression not conditioned on sexual activity (Table 2) is due to the later onset of sexual activity for white males relative to white females. A similar explanation holds for Mexican Americans relative to whites. Puerto Ricans now emerge as significantly more likely than whites to have had an STD at Wave 1 (although not because of differences in age at first intercourse). Nativity status is not significantly associated with STD risk.

The effects of family background characteristics on STD risk, already minimal, are further reduced. Teenagers living in stepfamilies are no longer more likely to have had an STD. The increased likelihood seen earlier can be explained by their higher risk of becoming sexually experienced. The effect of mother's education remains: As mother's education increases, STD risk at Wave 1 declines. Neighborhood residential stability remains significant and in the expected direction; however, neighborhood unemployment becomes insignificant. Lastly, the school status effect shown in Table 2 is not significant in regression 1 of Table 4, and thus is explained by differences in age at first intercourse. That is, reduced STD risk among teenagers attending private schools is due to their delay in first sex.

The next three regressions in Table 4 pertain to the analysis of STD acquisition as of Wave 2. Teenagers not reinterviewed at Wave 2 differ to some degree from those who were. Because attrition between waves might influence the results for STD risk at Wave 2, regression 2 replicates regression 1 for sexually experienced teenagers who were reinterviewed at Wave 2. Overall, the results for the two samples are similar, but there are some differences: The white–Puerto Rican contrast and maternal education are no longer significant, whereas the white–Mexican American contrast and the junior high–high school contrast become significant.

As noted earlier, there is design selectivity in the definition of eligible Wave 2 respondents. In addition, Wave 2 respondents are incidentally selected on STD risk. In these data, female teenagers and those with the earliest sexual initiation—both more likely to have experienced an STD—are more likely than males and those with later sexual initiation to experience attrition. Finally, and perhaps most importantly, the Wave 2 sample size used in the regressions is about half that of the Wave 1 sample size. Taken together, these findings suggest that the Wave 1 sexually experienced sample is more representative than a sample of those interviewed at both waves for assessment of STD experience as of Wave 1.

We next consider regressions 2 and 3 in Table 4. Regression 2 pertains to STD risk at Wave 1; regression 3 pertains to STD risk between Waves 1 and 2. The covariates and respondents for the two regressions are identical. The response variables differ only with respect to time reference.

***TABLE 4. Logistic regressions of STD acquisition among sexually experienced teenagers, by selected characteristics, with random intercept at school community level***

| Characteristic | Wave 1 | | Between waves | |
|---|---|---|---|---|
| | Model 1† (N=6,321) | Model 2‡ (N=3,396) | Model 3‡ (N=3,396) | Model 4‡ (N=3,396) |
| INDIVIDUAL | | | | |
| **Age at Wave 1** | 0.30*** | 0.27*** | 0.16* | 0.10 |
| **Age at first intercourse (ref=≤13)** | | | | |
| 14–16 | –0.53*** | –0.70*** | –0.39* | –0.26 |
| ≥17 | –1.00*** | –0.95** | –0.46 | –0.17 |
| Missing data | –0.38 | 0.04 | –0.40 | –0.38 |
| **Male** | –1.47*** | –1.57*** | –1.27*** | –1.03*** |
| **White male** | –0.10 | 0.18 | –0.06 | –0.11 |
| **Race/ethnicity (ref=white)** | | | | |
| Black | 0.82*** | 0.53** | 0.46* | 0.42* |
| Cuban | –0.73 | –1.27 | 0.35 | 0.67 |
| Puerto Rican | 0.59* | 0.41 | 0.44 | 0.38 |
| Mexican American | –0.36 | –0.83* | 0.19 | 0.26 |
| Other Hispanic | –0.13 | –0.17 | 0.23 | 0.27 |
| Asian American | –0.50 | –0.15 | 0.26 | 0.33 |
| Native American | 0.15 | 0.62 | 0.46 | 0.43 |
| Other | 0.16 | –0.30 | –0.21 | –0.06 |
| **Nativity status (ref=U.S.-born)** | | | | |
| Foreign-born | 0.29 | 0.28 | –0.60 | –0.69 |
| FAMILY | | | | |
| **Family structure (ref=both biological parents)** | | | | |
| Biological mother and stepfather | 0.29 | 0.02 | 0.31 | 0.27 |
| Biological father and stepmother | 0.12 | 0.32 | –0.44 | –0.50 |
| Biological mother and cohabiting partner | 0.62 | 0.69 | –0.69 | –0.92 |
| Biological father and cohabiting partner | –0.31 | 0.74 | –0.72 | –0.91 |
| Biological mother only | 0.62 | 0.33 | –0.42 | –0.58 |
| Biological father only | 0.21 | 0.37 | –1.02 | –1.11 |
| Other | 0.12 | –0.17 | –1.69* | –1.74* |
| **Parental education** | | | | |
| Mother | –0.06* | –0.05 | –0.12*** | –0.12** |
| Father | –0.00 | –0.01 | –0.01 | –0.01 |
| **Father's occupation status (ref=high)** | | | | |
| Low | 0.38 | 0.37 | –0.13 | –0.20 |
| None | 0.41 | 0.40 | 0.45 | 0.37 |
| **Mother's presence in the morning** | –0.03 | –0.02 | –0.05 | –0.04 |
| **Father's presence in the morning** | 0.00 | –0.07 | –0.07 | –0.05 |
| NEIGHBORHOOD | | | | |
| **Residential stability** | –0.10** | –0.17** | –0.05 | –0.03 |
| **Unemployed** | 0.08 | 0.09 | 0.05 | 0.03 |
| SCHOOL | | | | |
| **Status (ref=public)** | | | | |
| Catholic | 0.03 | –0.18 | 0.20 | 0.19 |
| Private | –1.10 | –0.73 | –0.25 | –0.19 |
| **Type (ref=junior high)** | | | | |
| High | 0.32 | 0.89* | 0.07 | –0.11 |
| Combination | 0.11 | 0.48 | 0.37 | 0.30 |
| **Had an STD by Wave I** | na | na | na | 1.69*** |
| *Constant* | *–6.72**** | *–6.29**** | *–2.71** | *–1.90* |
| *Log likelihood* | *–1,397.19* | *–702.12* | *–793.60* | *–757.10* |
| *Wald $\chi^2$* | *325.51**** | *155.42**** | *111.01**** | *198.91**** |
| *df* | *34* | *34* | *34* | *35* |
| *Intraclass correlation* | *<0.01* | *0.03* | *0.02* | *<0.01* |

*p≤.05.**p≤.01.***p≤.001.†Among adolescents who were sexually experienced at Wave 1.‡Among adolescents who were sexually experienced at Wave 1 and were reinterviewed at Wave 2. *Note:* ref=reference group. na=not applicable.

***TABLE 5. Alternative estimates of differences in the risk of acquiring an STD between survey waves, by family type, adjusted for absence of mother or father***

| Family structure | Model excludes STD history at Wave 1 | Model includes STD history at Wave 1 |
|---|---|---|
| Both biological parents | 0.00 | 0.00 |
| Biological mother and stepfather | 0.31 | 0.27 |
| Biological father and stepmother | –0.44 | –0.45 |
| Biological mother and cohabiting partner | –0.25 | –0.39 |
| Biological father and cohabiting partner | 1.08 | 0.78 |
| Biological mother only | 0.03 | –0.05 |
| Biological father only | 0.78 | 0.58 |
| Other | 0.56 | 0.48 |

*Note:* Computations are based on univariate statistics presented in Table 1 and on regressions 3 and 4 in Table 4. Adjustments use mean parental education, sample proportions for father's occupational status and mean parental presence.

Thus, it is not surprising that the two regressions have similar coefficients for most variables. Age and age at first intercourse affect risk, as do gender and race and ethnicity. There are some differences. Residential stability and the high school contrast are no longer significant for this selected subsample of Wave 2 respondents. Also, at Wave 2, the other family structure category is significant, as is mother's education. The other family structure contrast with two-biological-parent families cannot be understood without considering the other parent-related covariates in the regression (see below).

The most important reason for analyzing self-reported STD experience between Waves 1 and 2 is that doing so enables examination of the extent to which previous STD experience affects subsequent STD experience. The final regression in Table 4 extends the covariate list of regression 3 to include a dummy variable for STD at Wave 1. The coefficient for report of an STD at Wave 1 is highly statistically significant and positive: Teenagers who reported having had a prior STD are much more likely than others to report an STD between Waves 1 and 2, controlling for individual, family, neighborhood and school characteristics. Moreover, once STD at Wave 1 is included in the regression, the coefficients for age and age at first intercourse become insignificant. Apart from the effect of STD at Wave 1, the remaining significant coefficients are for the gender and white-black contrasts, and the family structure effect.

### Contrasts by Family Structure

Postestimation computation is required to accurately evaluate the family structure contrasts. The model coefficients cannot be interpreted without taking the other parental measures in the model into consideration. Table 5 presents the results of the postestimation calculations for regressions 3 and 4. These calculations can be interpreted as regression standardizations in which the family structure categories are evaluated at the mean of parental education, the sample proportions for father's occupational status and the mean of the parental presence variables. Compared with teenagers living with both biological parents, those living in other family situations are at higher risk of STD between Waves 1 and 2, when the other parental variables are set at the centers of their distributions.

We also estimated a model excluding the parental variables. In this instance, the family structure contrasts are directly interpretable. When STD at Wave 1 is excluded from the regression, the coefficient for other family situations is significant and positive; however, when STD at Wave 1 is included, the coefficient for other family situations is not significant (not shown). We would expect teenagers not living under the umbrella of parental protection to be at greater risk of STD acquisition, and this is what we found at the mean.

## DISCUSSION

Self-reports of STD, which could just as well be called indirect reports of STD, are often disparaged for their presumed measurement error. The belief is that those who know they have a positive STD history tend to deny it. To the extent that this occurs, the estimated probability of ever having had a diagnosed STD should be lower than the true probability, and the absolute values of the regression coefficients should be reduced relative to their true values. Although we are unable to assess the extent of underreporting bias, we would not be surprised by its existence. Nonetheless, it is clear that not all of the regression coefficients in our analysis are zero, and that the effects are in the hypothesized directions. Moreover, audio-CASI techniques have been shown to improve underreporting of sensitive behaviors.[40] In cross-sectional sample surveys of the general population, biomarker tests detect contemporaneous, largely asymptomatic STDs.[41] Self-reports of STDs constitute measurement of previously diagnosed and most often symptomatic infection, and there is evidence that a positive STD history predicts subsequent infection.[42] Thus, our findings provide strong support for the continued use of STD self-report in sample surveys.

Studies based on STD self-reports obtained from probability samples of the general population have advantages: Their estimates are representative of the general population; they can allow for assessment of the influences of multiple dimensions; and they can sustain behavioral modeling of STD risk—the kind of modeling illustrated here. Studies based on surveillance data, or on clinical data, are subject to bias in the sampling of STD cases. With data on STD cases generated through the surveillance system, there is also no possibility for rich measurement and modeling of the process that translates risk factors into outcomes.

Compared with STD biomarker testing in surveys of the general population, self-reports are easy and inexpensive to collect. Low prevalence rates for STD infections estimated from biomarker collection at the time of interview imply that very large samples of the general population are needed to obtain enough positive tests to sustain multivariate, behavioral modeling. Prospective, rather than

cross-sectional, designs can overcome the sparseness problem, but the expense of repeated interviews and STD biomarker testing is considerable. In light of the discussion above, we recommend that both self-reports and biomarkers be collected, because each provides unique information for STD risk assessment.

Among sexually experienced teenagers, 7% reported ever having had an STD by Wave 1, with females much more likely than males to have a history. Also, almost 7% of those sexually experienced teenagers who were reinterviewed at Wave 2 reported having had an STD between the two interview dates. Our estimates of STD prevalence are plausibly within range of those found by other researchers for adolescents and young adults.[43] Furthermore, our results are some of the first to provide a longitudinal assessment of STD risk using a national sample of adolescents.

Age at onset of sexual activity marks the beginning of a key behavior necessary for the contraction of a sexually transmitted disease. Among the sexually experienced, the earlier the onset, the more likely an individual is to report having had an STD at Wave 1. Age at onset largely, but not entirely, mediates covariate effects observed when regression estimation is based on both sexually experienced and uninitiated teenagers. Additionally, having a history of STD is strongly associated with an increased risk of subsequent STD, and prior STD mediates the effects of age and age at first intercourse on the risk of STD between waves. Although other sexual and protective practices are also relevant, these findings highlight the importance of age at first intercourse as a marker of STD risk[44] and are consistent with the results of earlier studies showing that STD history is strongly predictive of subsequent STD.[45]

Our findings confirm and extend prior research on STD risk among adolescents. It is important to take age at first intercourse into account; much of the effect of the environment of adolescents is filtered through age at onset. Additionally, an STD history is strongly predictive of subsequent infection. Our findings for gender, age, and race and ethnicity confirm those of previous research, but we provide new information for several racial and ethnic subgroups, as well as for nativity status. Although mother's education affects both age at first intercourse and STD risk directly, most of the effect of family background on STD risk is mediated by age at first intercourse. Neighborhood and school characteristics affect STD risk directly, as well as working through age at first intercourse. Thus, our findings support the hypothesis that multiple social contexts and behavioral factors are associated with the risk of STD acquisition among U.S. adolescents. Research that further incorporates this dynamic behavioral perspective to better understand STD risk is warranted.

From a policy perspective, our research indicates the central importance of age at first intercourse as a key determinant of the reproductive health of teenagers. It would be ill advised, however, to focus on this result at the expense of the other findings presented. Specifically, age at first intercourse is itself a function of family, neighborhood and school contexts, and these contexts affect STD acquisition even when age at first intercourse is controlled. Thus, attempts to modify age at first intercourse in the population that ignore differences in social and cultural contexts are unlikely to be efficient and effective in reducing STD risk and in improving adolescent reproductive health. Interventions for at-risk youth that recognize and attempt to incorporate underlying aspects of the social and cultural conditions that affect sexual risk risk-taking behaviors are warranted, as are strategies designed to improve the underlying conditions themselves.

## REFERENCES


**1.** Cates W, Jr., Estimates of the incidence and prevalence of sexually transmitted diseases in the United States, *Sexually Transmitted Diseases*, 1999, 26(Suppl. 4):S2–S7; Centers for Disease Control and Prevention (CDC), *Sexually Transmitted Disease Surveillance 1999*, Atlanta: CDC, 2000; and Weinstock H, Berman S and Cates W, Jr., Sexually transmitted diseases among American youth: incidence and prevalence estimates, 2000, *Perspectives on Sexual and Reproductive Health*, 2004, 36(1):6–10.

**2.** Eng TR and Butler WT, eds., *The Hidden Epidemic: Confronting Sexually Transmitted Diseases*, Washington, DC: National Academy Press, 1997.

**3.** U.S. Department of Health and Human Services, *Healthy People 2010: Understanding and Improving Health,* second ed., Washington, DC: U.S. Government Printing Office, 2000.

**4.** Aral SO, Sexual network patterns as determinants of STD rates: paradigm shift in the behavioral epidemiology of STDs made visible, *Sexually Transmitted Diseases*, 1999, 26(5):262–264.

**5.** Cohen D et al., "Broken windows" and the risk of gonorrhea, *American Journal of Public Health*, 2000, 90(2):230–236; Ford K and Norris A, Sexual networks of African-American and Hispanic youth, *Sexually Transmitted Diseases*, 1997, 24(6):327–333; Katz BP et al., Partner-specific relationship characteristics and condom use among young people with sexually transmitted diseases, *Journal of Sex Research*, 2000, 37(1):69–75; Laumann EO and Youm Y, Racial/ethnic group differences in the prevalence of sexually transmitted diseases in the United States: a network explanation, *Sexually Transmitted Diseases*, 1999, 26(5):250–261; Morris M, Sexual networks and HIV, *AIDS*, 1997, 11(Suppl. A): S209–S216; Stoner BP et al., Comparative epidemiology of heterosexual gonococcal and chlamydial networks, *Sexually Transmitted Diseases*, 2000, 27(4):215–223; and Zenilman JM et al., The geography of sexual partnerships in Baltimore: applications of core theory dynamics using a geographic information system, *Sexually Transmitted Diseases*, 1999, 26(2):75–81.

**6.** Eng TR and Butler WT, 1997, op. cit. (see reference 2).

**7.** Miller HG et al., Correlates of sexually transmitted bacterial infections among U.S. women in 1995, *Family Planning Perspectives*, 1999, 31(1):4–9 & 23; Santelli JS et al., Multiple sexual partners among U.S. adolescents and young adults, *Family Planning Perspectives*, 1998, 30(6):271–275; and Sonenstein FL et al., Changes in sexual behavior and condom use among teenaged males: 1988 to 1995, *American Journal of Public Health*, 1998, 88(6):956–959.

**8.** Berman S and Hein K, Adolescents and STDs, in: Holmes KK et al., eds., *Sexually Transmitted Diseases,* third ed., New York: McGraw-Hill, 1999, pp. 129–142; and Eng TR and Butler WT, 1997, op. cit. (see reference 2).

**9.** Greenberg J, Madger L and Aral S, Age at first coitus: a marker for risky sexual behavior, *Sexually Transmitted Diseases*, 1992, 19(6):331–334.

**10.** Ibid.; Eng TR and Butler WT, 1997, op. cit. (see reference 2); and Santelli JS et al., 1998, op. cit. (see reference 7).

**11.** Kost K and Forrest JD, American women's sexual behavior and exposure to risk of sexually transmitted diseases, *Family Planning Perspectives*, 1992, 24(6):244–254; Miller HG et al., 1999, op. cit. (see

reference 7); and Upchurch DM and Kusunoki Y, Associations between forced sex, sexual and protective practices, and STDs among a national sample of adolescent girls, *Women's Health Issues*, 2004, 14(3): 75–84.

**12.** Cohen D et al., 2000, op. cit. (see reference 5); Ellen JM, Aral SO and Madger LS, Do differences in sexual behaviors account for the racial/ethnic differences in adolescents' self-reported history of a sexually transmitted disease? *Sexually Transmitted Diseases*, 1998, 25(3): 125–129; Ford K and Norris A, 1997, op. cit. (see reference 5); Eng TR and Butler WT, 1997, op. cit. (see reference 2); Laumann EO and Youm Y, 1999, op. cit. (see reference 5); Miller HG et al., 1999, op. cit. (see reference 7); Tanfer K, Cubbins LA and Billy JOG, Gender, race, class and self-reported sexually transmitted disease incidence, *Family Planning Perspectives*, 1995, 27(5):196–292; and Zenilman JM et al., 1999, op. cit. (see reference 5).

**13.** CDC, 2000, op. cit. (see reference 1).

**14.** Berman S and Hein K, 1999, op. cit. (see reference 8); and Eng TR and Butler WT, 1997, op. cit. (see reference 2).

**15.** Santelli JS et al., 1998, op. cit. (see reference 7); and Upchurch DM et al., Gender and ethnic differences in the timing of first sexual intercourse, *Family Planning Perspectives*, 1998, 30(3):121–127.

**16.** Soler H et al., Relationship dynamics, ethnicity and condom use among low-income women, *Family Planning Perspectives*, 2000, 32(2): 82– 88 & 101.

**17.** Santelli JS et al., 1998, op. cit. (see reference 7); Sonenstein FL et al., 1989, op. cit. (see reference 7); Tanfer K, Cubbins LA and Billy JOG, 1995, op. cit. (see reference 12); and Upchurch DM et al., 1998, op. cit. (see reference 15).

**18.** Ellen JM, Aral SO and Madger LS, 1998, op. cit. (see reference 12); and Laumann EO and Youm Y, 1999, op. cit. (see reference 5).

**19.** CDC, 2000, op. cit. (see reference 1).

**20.** Marin BV et al., Acculturation and gender differences in sexual attitudes and behaviors: Hispanic vs. non-Hispanic white unmarried adults, *American Journal of Public Health*, 1993, 83(12):1759–1761; and Upchurch DM et al., Sociocultural contexts of time to first sex among Hispanic adolescents, *Journal of Marriage and the Family*, 2001, 63(4): 1158–1169.

**21.** Fox GL, The family's role in adolescent sexual behavior, in: Ooms T, ed., *Teenage Pregnancy in a Family Context*, Philadelphia: Temple University Press, 1981, pp. 73–130; Maccoby EE and Martin JA, Socialization in the context of the family: parent-child interaction, in: Mussen PH, ed., *Handbook of Child Psychology,* vol.4, New York: Wiley, 1983, pp. 1–101; and Thornton A and Camburn D, The influence of the family on premarital sexual attitudes and behavior, *Demography*, 1987, 24(3):323–340.

**22.** Maccoby EE and Martin JA, 1983, op. cit. (see reference 21); and Peterson GW and Leigh GK, The family and social competence in adolescence, in: Gullota T, Adams G and Montemayor R, eds., *Advances in Adolescent Development: Social Competence*, Newbury Park, CA: Sage, 1990, pp. 97–138.

**23.** Day RD, The transition to first intercourse among racially and culturally diverse youth, *Journal of Marriage and the Family*, 1992, 54(4): 749–762; Harris KM, Duncan GJ and Boisjoly J, Evaluating the role of "nothing to lose" attitudes on risky behavior in adolescence, *Social Forces*, 2002, 80(3):1005–1039; Ramirez-Valles J, Zimmerman MA and Newcomb MD, Sexual risk behavior among youth: modeling the influence of prosocial activities and socioeconomic factors, *Journal of Health and Social Behavior*, 1998, 39(3):237–253; Upchurch DM et al., 1998, op. cit. (see reference 15); and Young EW et al., The effects of family structure on the sexual behavior of adolescents, *Adolescence*, 1991, 26(104):977–986.

**24.** Fox GL, 1981, op. cit. (see reference 21); Peterson GW and Leigh GK, 1990, op. cit. (see reference 22); and Rodgers KB, Parenting processes related to sexual risk-taking behaviors of adolescent males and females, *Journal of Marriage and the Family*, 1999, 61(1):99–109.

**25.** Luster T and Small SA, Factors associated with sexual risk-taking behaviors among adolescents, *Journal of Marriage and the Family*, 1994, 56(3):622–630; Metzler CW et al., The social context for risky sexual behavior among adolescents, *Journal of Behavioral Medicine*, 1994, 17(4):419–438; and Rodgers KB, 1999, op. cit. (see reference 24).

**26.** Upchurch DM and Kusunoki Y, 2004, op. cit. (see reference 11).

**27.** Sampson RJ, How do communities undergird or undermine human development? relevant contexts and social mechanisms, in: Booth A and Crouter AC, eds., *Does It Take a Village? Community Effects on Children, Adolescents, and Families*, Mahwah, NJ: Lawrence Erlbaum Associates, 2001, pp. 3–30; and Sampson RJ, Raudenbush SW and Earls F, Neighborhoods and violent crime: a multilevel study of collective efficacy, *Science*, 1997, 277(5328):918–924.

**28.** Billy JOG et al., The sexual behavior of men in the United States, *Family Planning Perspectives*, 1993, 25(2):52–60; Brewster KL, Race differences in sexual activity among adolescent women: the role of neighborhood characteristics, *American Sociological Review*, 1994, 59(3): 408–424; Brewster KL, Neighborhood context and the transition to sexual activity among young black women, *Demography*, 1994, 31(4): 603–614; Brewster KL, Billy JOG and Grady WR, Social context and adolescent behavior: the impact of community on the transition to sexual activity, *Social Forces*, 1993, 71(3):713–740; Hogan DP and Kitagawa EM, The impact of social status, family structure, and neighborhood on the fertility of black adolescents, *American Journal of Sociology*, 1985, 90(4):825–855; Ku L, Sonenstein FL and Pleck JH, Neighborhood, family, and work: influences on the premarital behaviors of adolescent males, *Social Forces*, 1993, 72(2):479–503; Ramirez-Valles J, Zimmerman MA and Newcomb MD, 1998, op. cit. (see reference 23); and Upchurch DM et al., Neighborhood and family contexts of adolescent sexual activity, *Journal of Marriage and the Family*, 1999, 61(4):920–933.

**29.** Eng TR and Butler WT, 1997, op. cit. (see reference 2); Potterat JJ, "Socio-geographic space" and sexually transmissible diseases in the 1990's, *Today's Life Sciences*, Dec. 1992, pp. 16–22 & 31; and Zenilman JM et al., 1999, op. cit. (see reference 5).

**30.** Sampson RJ, 2001, op. cit. (see reference 27); and Sampson RJ and Morenoff JD, Ecological perspectives on the neighborhood context of urban poverty: past and present, in: Brooks-Gunn J, Duncan GJ and Aber JL, eds., *Neighborhood Poverty: Policy Implications in Studying Neighborhoods*, New York: Russell Sage, 1997, pp. 1–22.

**31.** Cohen D et al., 2000, op. cit. (see reference 5); Kilmarx PH et al., Sociodemographic factors and the variation in syphilis rates among U.S. counties, 1984 through 1993: an ecological analysis, *American Journal of Public Health*, 1997, 87(12):1937–1943; and Ramirez-Valles J, Zimmerman MA and Newcomb MD, 1998, op. cit. (see reference 23).

**32.** McNeely CA, Nonnemaker JM and Blum RW, Promoting school connectedness: evidence from the National Longitudinal Study of Adolescent Health, *Journal of School Health*, 2002, 72(4):138–146; and Resnick MD et al., Protecting adolescents form harm: findings from the National Longitudinal Study on Adolescent Health, *Journal of the American Medical Association*, 1997, 278(10):823–833.

**33.** Bearman B and Bruckner H, *Power in Numbers: Peer Effects on Adolescent Girls' Sexual Debut and Pregnancy*, Washington, DC: National Campaign to Prevent Teen Pregnancy, 1999; Billy JOG et al., Community, neighborhood and school effects on adolescent sexual behavior, paper presented at the annual meeting of the Population Association of America, Minneapolis, May 1–3, 2003; Day RD, 1992, op. cit. (see reference 23); Furstenberg FF, Jr., et al., Race differences in the timing of adolescent intercourse, *American Sociological Review*, 1987, 52(4):511–518; Teitler JO and Weiss CC, Effects of neighborhood and school environments on transitions to first sexual intercourse, *Sociology of Education*, 2000, 73(2):112–132; and Kirby D, The impact of schools and school programs upon adolescent sexual behavior, *Journal of Sex Research*, 2002, 39(1):27–33.

**34.** Bearman PS, Jones J and Udry JR, *The National Longitudinal Study of Adolescent Health: Research Design*, 1997, University of North Carolina, Carolina Population Center <http://www.cpc.unc.edu/projects/addhealth/design>, accessed Apr. 8, 2004.

**35.** Ibid., accessed Mar. 22, 2004.

**36.** Paul C et al., What should we do about missing data? (a case study using logistic regression with missing data on a single covariate), California Center for Population Research On-Line Working Paper Series, 2003, <http://www.ccpr.ucla.edu/ccprwpseries/ccpr_028_03.pdf>, accessed Dec. 20, 2004.

**37.** Billy JOG, Wenzlow AT and Grady WR, *User Documentation for the Add Health Contextual Database*, Seattle: Battelle, Centers for Public

Health Research and Evaluation, 1998.

**38.** Stata, *Stata Statistical Software; Release 8.2*, College Station, TX: Stata, 2003.

**39.** Hoem J, Systematic patterns of zero exposures in event-history analysis, *Sociological Methodology*, 2000, 30(1):237–259.

**40.** Turner CF et al., Adolescent sexual behavior, drug use, and violence: increased reporting with computer survey technology, *Science*, 1998, 280(5365):867–873.

**41.** Ku L et al., Risk behaviors, medical care, and chlamydial infection among young men in the United States, *American Journal of Public Health*, 2002, 92(7):1140–1143; and Turner CF et al., Untreated gonococcal and chlamydial infection in a probability sample of adults, *Journal of the American Medical Association*, 2002, 287(6):726–733.

**42.** Eng TR and Butler WT, 1997, op. cit. (see reference 2).

**43.** Ellen JM, Aral SO and Madger LS, 1998, op. cit. (see reference 12); Miller HG et al., 1999, op. cit. (see reference 7); Tanfer K, Cubbins LA and Billy JOG, 1995, op. cit. (see reference 12); and Laumann EO et al., *The Social Organization of Sexuality: Sexual Practices in the United States*, Chicago: University of Chicago Press, 1994.

**44.** Greenberg J, Madger L and Aral S, 1992, op. cit. (see reference 9).

**45.** DiClemente RJ et al., Associations of adolescents' history of sexually transmitted disease (STD) and their current high-risk behavior and STD status: a case for intensifying clinic-based prevention efforts, *Sexually Transmitted Disease*, 2002, 29(9):503–509; and Eng TR and Butler WT, 1997, op. cit. (see reference 2).

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